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PATENT ABSTRACTS OF JAPAN

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(54) ROUTE CONTROL METHOD AND APPARATUSAND COMPUTER PROGRAM

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a route control method and apparatusand a computer program that can create and select a route wherein a few number of duplicate links and duplicate nodes are present.
SOLUTION: The route control method in a network tentatively formed among a plurality of nodes includes: a step of broadcasting a detection request of a destination node; a step S1 of receiving a response (RREP) from the destination node in response to the detection request; steps S3S5 of referencing the number of joints included in the response and registering the number; a step S9 of incrementing the number of joints by '1' and transmitting the result when there are a plurality of links (feedback paths) that transmit their responses; and a step of selecting a link whose number of registered joints is smallest as a route when there are a plurality of links for transmitting data to the destination node.

CLAIMS

[Claim(s)]
[Claim 1]
It is a path control method in a network temporarily formed among two or more nodes
A process in which a discovery request of a destination node is broadcast
A process in which a response from a destination node to said discovery request is received
A process registered with reference to the number of joint contained in said

response
A process in which add 1 to said number of jointand it transmits to it when there are two or more links which transmit the response concerned
A process in which a link with said registered smaller number of joint is chosen as a course when there are two or more links which transmit data to said destination node
A ****(ing) path control method.
[Claim 2]
A process in which said registered number of joint will be changed if the number of joint contained in the another response concerned is larger than the number of joint contained in the first response when another response is received after reception of said response
The path control method according to claim 1 having in a pan.
[Claim 3]
The path control method according to claim 1 or 2 when a purport of unlinking is receivedwherein a link which transmits data to said destination node performs control which does not send a purport of unlinking with plurality.
[Claim 4]
It is a device which controls a course in a network formed temporarily among two or more nodes
It is provided in said each node
A discovery request of a destination node is broadcast
A response from a destination node to said discovery request is received
It registers with reference to the number of joint contained in said response
When there are two or more links which transmit the response concerned1 is added to said number of jointand it transmits to it
A path control apparatus characterized by choosing a link with said registered smaller number of joint as a course when there are two or more links which transmit data to said destination node.
[Claim 5]
It is a computer program for controlling a course in a network formed temporarily among two or more nodes
A process in which a discovery request of a destination node is broadcast
A process in which a response from a destination node to said discovery request is received
A process registered with reference to the number of joint contained in said response
A process in which add 1 to said number of jointand it transmits to it when there are two or more links which transmit the response concerned
A process in which a link with said registered smaller number of joint is chosen as a course when there are two or more links which transmit data to said destination node
A computer program performing a computer.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention]
This invention relates to the path control method and device in networks temporarily formed among two or more nodessuch as what is called a multi-hop networkand a computer program.
[0002]
[Description of the Prior Art]
The research and development what is called about a multi-hop (or ad hoc) network have started. This multi-hop network is a network constituted by the meeting of a node with the function as a router.
For exampleit is temporarily formed among two or more terminals in which short distance communication is possibleand the home network to which interconnection of the information home appliance is carried out by the radio called Bluetootha temporary network in the conference halletc. are assumed.

[0003]
By the wayas shown in drawing 11the course of a before [transmission source node S of data and destination node D] is provided by set of the nodes N1-N4 which relay a data packet. In this casewhen the node N1 moves out of this networkfor examplethe link between N1 and S is cutbut since the course between S-N3-N4-D remainsthe course here can be chosen and course restoration can be performed promptly.
[0004]
On the other handas shown in drawing 12when the link between S-N1 overlaps and this link is cutcourses will be cut [no] and course restoration becomes impossible. Since it is suchit is required to perform path control so that a course as shown in said drawing 11 may be created.
[0005]
Since it is suchthere is a technique called DSR (Dynamic Source Routing) and AODV (Ad hoc On-demand Distance Vector Protocol) as path control in an ad hoc network. FurthermoreThe latter. Extended AOMDV (Ad hoc On-demand.) Multipath Distance Vector. Protocol is advocated (M. K. Marina and S.R. DasIn Proceedings of the International Conference for Network protocolNov. 2001).
[0006]
This AOMDV method is a protocol which creates two or more courses without a duplication link like said drawing 12. The course creation procedure in AOMDV is explained with reference to drawing 13. FirstS broadcasts the message (RREQ) for searching for D. There is a field which registers the address of the node which received first in this messageand it is un-registering at the time of transmission of S. N1 and N2 which received the message from S get to know that self is the node

which received this message firstand they register and broadcast a self address to a described arearespectively. Although the node I overlaps and receives the message from N1 and N2it acquires and broadcasts only the message of a direction (a figure N1) which received firstand others reject it. Hencefortha message relays N3 and N4respectivelyand reaches to Dand a transfer path is acquired. If each node carries out the unicast of the response to the node N3 which D broadcast that a message wasand the node which carried out the unicast of the response message (RREP) to N4and was broadcast after thata feedback path contrary to a transfer path will be created.

[0007]

The feature of the AOMDV method is at the following point. Usuallyif duplication reception of the broadcast message is carried outthe message from after will be rejected unconditionallybut. in the AOMDV methodwhen the message (N1) and address which receiving node (I) already received with reference to the above-mentioned address registered area in a message differ from each otherprocessing which updates a feedback path is performed (the unicast of the RREP is carried out to the transmitting origin) -- it is like. Therebysince I becomes a relay node which forms a link respectively separate from N1 and N2and a link intersectsthe course which does not have a duplication link as a result accomplishes two or more works.

[0008]

[Problem(s) to be Solved by the Invention]

Howeverin the case of the above-mentioned techniquethere are the following problems. That isas shown in drawing 14it is equivalent to the node Iand when two or more relay node X which two or more links intersectand Y existthe fault that duplication link X-N3-Y arises is between relay node X and Y. This is based on the following reason. Firstalthough the node X receives a RREQ message from N1 and N2it broadcasts only the message (N1) which received first. Although this message is broadcast by the node Y via N3 and N4respectivelysince these addresses are the same (N1)the message from after is rejected unconditionally at Y. As a resultsince the course which passes along N4 of the rejected direction is not formedthe above-mentioned duplication link will produce it.

[0009]

In the network which this invention was made in view of the above-mentioned problemand is temporarily formed among [such as an ad hoc network] two or more nodesIt aims at providing creationa selectable path control methoda deviceand a computer program for a course with few duplication links and duplication nodes.

[0010]

[Means for Solving the Problem]

In order to attain the above-mentioned purposeas for this inventionthe path control method according to claim 1 is characterized by that a path control method in a network temporarily formed among two or more nodes comprises the following.

A process in which a discovery request of a destination node is broadcast.

A process in which a response from a destination node to said discovery request is received.
A process registered with reference to the number of joint contained in said response.
A process in which add 1 to said number of jointand it transmits to it when there are two or more links which transmit the response concernedand a process in which a link with said registered smaller number of joint is chosen as a course when there are two or more links which transmit data to said destination node.

Since the number of joint is increased and a course with few joint was chosen when two or more links were connected with a situation with two or more links which transmit said responsei.e.one nodewhen done in this wayA course with which two or more links are connected can be avoided to one nodeand a course with few duplication links and duplication nodes can be created and chosen as it.
[0011]
If the number of joint contained in the another response concerned is larger than the number of joint contained in the first response when another response is received after reception of said responseit is preferred to have further a process in which said registered number of joint is changed.
Since the largest number of joint will be registered into a node which received a response if it does in this waya network state is correctly reflected in the number of jointand channel selection based on the number of joint can be performed correctly.
[0012]
When a purport of unlinking is receivedit is preferred that a link which transmits data to said destination node performs control which does not send a purport of unlinking with plurality.
If it does in this wayall the nodes which received a purport of unlinking will send this furtherand fault which causes useless data processing in the network increase of traffic and each nodeetc. will be prevented.
[0013]
A path control apparatus of this invention is a device which controls a course in a network formed temporarily among two or more nodesIt is provided in said each nodebroadcast a discovery request of a destination nodeand a response from a destination node to said discovery request is receivedWhen there are two or more links which register with reference to the number of joint contained in said responseand transmit the response concernedWhen there are two or more links which add 1 to said number of jointtransmit to itand transmit data to said destination nodea link with said registered smaller number of joint is chosen as a course.
[0014]
A process in which is for a computer program of this invention controlling a course in a network formed temporarily among two or more nodesand a discovery request of a destination node is broadcastA process in which a response from a

destination node to said discovery request is receivedand a process registered with reference to the number of joint contained in said responseA process in which add 1 to said number of jointand it transmits to it when there are two or more links which transmit the response concernedWhen there are two or more links which transmit data to said destination nodea computer is made to perform a process in which a link with said registered smaller number of joint is chosen as a course.

[0015]

[Embodiment of the Invention]

Hereafteran embodiment of the invention is described with reference to each figure. Drawing 1 is an example of the configuration block figure of the node (terminal) which forms a temporary network with which this invention is used. In this inventioneach node shall turn into transmission source node Sdestination node Dand the node (relay) Nrespectively.

[0016]

In this figureeach nodeVia the control section (path control apparatus) 2 which controls the wholethe application (computer program) 4 which recorded the various processing performed by this inventionthe protocol part 6 which performs predetermined protocol controlthe routing parts 8 which perform a routing functionand the wireless communication antenna 10a. It has the path control table 12 which registers the variety of information for the wireless section 10 for performing other nodes and radioand path control.

[0017]

As for drawing 2drawing 3 shows the format of a response message [as opposed to it for the format of the discovery request message (RREQ) of a destination node] (RREP). In drawing 2the address (Source IP address) of the sending person of RREQ is recorded on the IP header including the AODVM message which uses RREQ by the IP headeran UDP headerand this invention. Distination IP of an AODVM message An address and Originator IP As for an addressaddress (D) and transmitting origin specifies (S)respectively. This format is the same as that of what is used by the conventional AODV.

[0018]

As for RREPin drawing 3the address (Source IP an address and Distination IP address) of the transceiver person of RREP is recorded on the IP header including the IP headerthe UDP headerand the AODVM messagerespectively. In an AODVM messagealthough it is the feature of this invention to newly have provided the joint count fieldthis is mentioned later.

[0019]

Nextthe general procedure of the path control which the node which received the above-mentioned RREQ and RREP performs is explained with reference to drawing 4. In this figurethe case where a course is created between transmission source node Sthe relay node NANBand destination node D is considered. FirstS broadcasts RREQ (broadcasting). RREQ **** NA and NB in order and reaches to D. At this timeNA and NB register the following information as a "feedback path"

to the path control tables 12A and 12B of selfrespectively. This feedback path is a course for returning to Sand registers into the item "Next hop" from which node RREQ was received for "S" in the item "Des (tination)." Refer to the IP header of RREQ for from which node RREQ was received.

[0020]

On the other handD will transmit RREP to the transmitting origin referred to from the IP header of RREQif RREQ is received (unicast). RREP **** NB and NA in order and reaches to S. At this timeNA and NB register the following information as a "transfer path" to the path control tables 12A and 12B of selfrespectively. This transfer path is a course for sending data to Dand registers into the item "Next hop" from which node RREP was received for "D" in the item "Des (tination)." Refer to the IP header of RREP for from which node RREP was received. If a feedback path and a transfer path are acquired as mentioned abovethe course between nodes will be formed.

[0021]

Nextthe path control in a actual network is explained. Drawing 5 is a figure showing the composition of the whole network formed of each node. In this figurea network is formed of SDand two or more relay nodes N10-N16. A solid line shows the link (wireless communication network) formed between each node.

[0022]

And in this networksupposing S broadcasts RREQeach node will record the node which serves as a course (feedback path) to S based on RREQ which received on the path control table of self. The arrow S of the figure expressed the feedback path of each nodeand has pointed out the node used as the course to S in the direction of an arrow. If RREQ is broadcast by even DD will transmit RREP (unicast). By transmitting RREP which each node which received RREP received toward S using the created feedback path alreadyRREP reaches even S. At this timeeach node records the node which serves as a course (transfer path) to D based on RREP which received on the path control table of self. The arrow D of the figure expressed the transfer path of each nodeand has pointed out the node used as the course to D in the direction of an arrow. When it does in this wayin the example of a figurea feedback path and a transfer path will certainly be created between each node. Since RREQ which came later depending on the address registered area in RREQ is not canceled like the conventional AOMDV methodit becomes impossible that isto create the course which does not overlap since a course is not created between nodes.

[0023]

Howeverwhen using the created course at randomsimple two or more courses will be created and a course including a duplication link exists in it. Thenthe following processings are provided and it enables it to choose the course which does not include a duplication link.

In this processingeach node performs the procedure (flow) shown in drawing 6. In this figureeach nodes N10-N16 receive RREP first (Step S1). joint count shown in said drawing 3 at RREP The field is provided and refer to the value (the number of

joint) for each node (Step S3). Herethe number of joint is set as 0when destination node D transmits RREP first. Each node registers the value (the number of joint) referred to for every transfer path of a path control table (Step S5).

[0024]

Nextwith reference to the path control table of selfit is judged whether each node has two or more feedback paths which should transmit this RREP (Step S7). Hereit is judged whether two or more nodes are registered into the item "Next hop" in a feedback path. In "Yes"each node is joint count of RREP at Step S7. 1 is added to the value of the field and it transmits to the node of a transmission destination (Next hop) (step S9). On the other handin "No"each node transmits RREP to the node of a transmission destination at Step S7 with the value (it was referred to) of a basis (Step S11).

[0025]

Drawing 7 and drawing 8 show the data of the path control table of each node in processing of said drawing 6. Drawing 7 and drawing 8 are data of the node N16 of said drawing 5and the path control table of N14respectively.

[0026]

In drawing 7since N16 receives RREP directly from Dthe number of joint contained in RREP is 0. Therefore0is registered into the "joint count" field of a transfer path (transmission path to D). on the other hand -- the feedback path of N16 -- twoN13 and N15-- it is . Thereforesince judgment of the above-mentioned step S7 serves as "Yes"N16 transmits RREP (1 was added to 0) which set the number of joint to 1 to N13 and N15respectively.

[0027]

In drawing 8N14 receives RREP from N13 and N15respectively. Hereas shown in drawing 9the number of joint of RREP to which the number of joint of RREP transmitted from N13 is transmitted from 2 and N15 is 1. Thereforethe inside "next hop" of a transfer path (transmission path to D) registers "2" into the "joint count" field of N13and "next hop" registers "1" into the "joint count" field of N15. On the other handthe number of the feedback paths of N14 is oneand since judgment of the above-mentioned step S7 serves as "No"N14 transmits RREP which does not change the number of joint of a basis to S.

[0028]

By the waylike the node N14when there are two or more transfer pathsthe following problems arise. That iswhich value should be registered into the path control table of self among the numbers of joint by which the node which transmits RREP to S which is a feedback path is contained in RREP which S received from each node since only the number of transfer paths overlaps poses a problem. Thenif the receiving node (S) of RREP has the number of joint larger than the number of joint already registered into the table in RREP which received later when RREP another after receiving RREP is receivedit will change the number of joint. Since the largest number of joint will be registered into the receiving node of RREP if it does in this waya network state is correctly reflected in the number of jointand channel selection based on the number of joint can be performed

correctly.
[0029]
By the above processingas it is shown in drawing 9the number of joint for every transfer path is registered into the table of each node. In this figurealthough there are N10 and N14 as a transfer path of Sthe arrow D in a figure shows a transfer pathand that subscript (2) shows the number of joint.
[0030]
Nexthow to choose a course using the number of joint of above-mentioned drawing 9 is explained. FirstS transmits the data (packet) which the number of joint transmits to the address D between two transfer pathsN10 and N14using few directions with reference to the path control table of self. Heresince any number of joint of a transfer path is the same value (2)S determines a transfer path at random. At drawing 9it is the transfer path 1. It should ******.
[0031]
NextN10 which received data transmits data with reference to the path control table of self using a direction with few numbers of joint between two transfer pathsN11 and N13. Since the number of joint has here few transfer paths which relay N11it is the transfer path 2. It ******. Hereaftersince the number of transfer paths is one in the case of N11 and N12it is the transfer path 3. 4It ******. Thus1 -4 Although ****** is chosensince the relay node which duplication-links or overlaps does not existthis course is a course with few troublessuch as course cutting. Similarlythe relay node to which it duplication-links or the course of S-N14-N15-N16-D also overlaps does not exist.
[0032]
By the waywhen course cutting arisesthe node located in the cut link broadcasts the error message which tells the purport of cutting using a feedback path. Howeverif all the nodes which received this message broadcast a message furtheruseless data processing in the network increase of traffic and each nodeetc. may be caused. Thenin this embodimentas it is shown in drawing 10the transmission control of an error message is performed.
[0033]
Suppose that the link between N12-D was cut in drawing 10 (course 1). N12 located in a cutting link detects cuttingand broadcasts an error message (the arrow E of a figure). Herebroadcast of 1HOP is considered. N11 which received the message gets to know that the number of transfer paths is one (from N11 to N12) with reference to the path control table of self. Each node gets one transfer path blockedwhen there is no alternate route which avoids a cutting linkan error message is broadcast and N11 broadcasts an error message. N11 sets again the flag of the purport that course cutting was carried outto the transfer path of a path control table.
[0034]
On the other handwith reference to the path control table of selfas for N13 which received the error message from N12two transfer paths (from N13 to N13 to N12 and N16) get to know a certain thing. Since each node chooses other alternate

routes which do not go via a cutting linkwithout broadcasting an error message when there are two transfer pathsN13 does not broadcast an error message. Since similarly N10 which received the error message from N11 has two transfer paths (from N10 to N10 to N11and N13)an error message is not broadcast. Thusthe broadcast numbers of an error message can be reduced to the minimum. N13 and N10 set the flag of the purport of opposite Perilla frutescens (L.) Britton var. crispa (Thunb.) Decne. to that by which course cutting was carried out among the transfer paths of the path control table of self.

[0035]

Nextthe selection method of the alternate route based on the above-mentioned error message is explained. Firstthe number of joint makes channel selection of either at random from two transfer pathsthe N10 [same] and N14the same with having explained in said drawing 9and S transmits the data transmitted to the address D. Herewhen the course N14 is chosenit is as having already stated that the course 3 in which neither the duplication link S-N14-N15-N16-Dnor the overlapping relay node exists is chosen. On the other handwhen the course N10 is chosenN10 gets to know that the course which goes to N11 is cut with reference to the flag of the transfer path of a path control table. ThenN10 chooses a transfer path (course which goes to N13) without a flagand transmits data. N13 which received data chooses similarly a transfer path (course which goes to N16) without a flag with reference to a path control tableand transmits data. And N16 transmits data to D. Thusthe course 2 is chosen.

[0036]

The path control method of this invention A computer and various peripheral equipmentsuch as a communication apparatusThe software program executed by the computer can realizeand the software program executed within the above-mentioned system can be distributed via the storage or communication line in which computer reading is possible.

[0037]

[Effect of the Invention]

The situation which has two or more links which transmit said response according to this invention according to claim 1 as explained aboveThat issince the number of joint is increased and the course with few joint was chosen when two or more links had led to one nodethe course with which two or more links are connected can be avoided to one nodeand a course with few duplication links and duplication nodes can be created and chosen as it. Also when a predetermined course is cutwith reference to the number of jointan alternate route can be chosen promptly.

[0038]

According to this invention according to claim 2since the largest number of joint is registered into the node which received the responsea network state is correctly reflected in the number of jointand channel selection based on the number of joint can be performed correctly.

[0039]

According to this invention according to claim 3all the nodes which received the

purport of unlinking send this furtherand the fault which causes useless data processing in the network increase of traffic and each nodeetc. is prevented.

[Brief Description of the Drawings]

[Drawing 1]It is a figure showing the configuration block of the node (terminal) which forms a temporary network.

[Drawing 2]It is a figure showing the format of the discovery request message (RREQ) of a destination node.

[Drawing 3]It is a figure showing the format of the response message (RREP) over RREQ.

[Drawing 4]It is a figure showing the general procedure of the path control which a node performs.

[Drawing 5]It is a figure showing the composition of the whole network formed of each node.

[Drawing 6]It is a figure showing the flow which each node which received RREP performs.

[Drawing 7]It is a figure showing the data registered into the path control table according to the flow of drawing 6.

[Drawing 8]It is another figure showing the data registered into the path control table according to the flow of drawing 6.

[Drawing 9]It is a figure showing the number of joint set as each link.

[Drawing 10]When course cutting is carried outit is a figure showing the procedure which chooses an alternate route.

[Drawing 11]It is a figure showing the channel selection of the conventional multi-hop network.

[Drawing 12]It is another figure showing the channel selection of the conventional multi-hop network.

[Drawing 13]It is another figure furthermore the channel selection of the conventional multi-hop network is shown.

[Drawing 14]They are other figures showing the channel selection of the conventional multi-hop network.

[Description of Notations]

S1 Process in which the response (RREP) from the destination node to the discovery request of a destination node is received

S3S5 Process registered with reference to the number of joint contained in a response

S9 Process in which add 1 to the number of joint and it transmits to it when there are two or more links (feedback path) which transmit a response

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1]It is a figure showing the configuration block of the node (terminal) which forms a temporary network.

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[Drawing 12]It is another figure showing the channel selection of the conventional multi-hop network.
[Drawing 13]It is another figure furthermore the channel selection of the conventional multi-hop network is shown.
[Drawing 14]They are other figures showing the channel selection of the conventional multi-hop network.
[Description of Notations]
S1 Process in which the response (RREP) from the destination node to the discovery request of a destination node is received
S3S5 Process registered with reference to the number of joint contained in a response
S9 Process in which add 1 to the number of joint and it transmits to it when there are two or more links (feedback path) which transmit a response